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Influence of plant growth regulators on growth, seed yield, quality and economics of coriander (*Coriandrum sativum* L.) cv. *Sudha*

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Abstract

A field experiment was conducted to study the effect of plant growth regulators (PGRs) on growth, seed yield, quality and economics of coriander (*Coriandrum sativum* **L.) cv. *Sudha***. The seven treatments included in the experiment are two concentrations each of GA_3 (50 and 75 ppm), NAA (10 and 25 ppm), Cycocel (100 and 250 ppm) and control (water spray), as pre-soaking, foliar spray at 30 and 60 DAS. Among different PGRs applied, spray of 75 ppm GA_3 resulted in significant maximum plant height. However, maximum number of primary branches and secondary branches plant^{-1}, number of umbels plant^{-1}, number of umbellets umbel^{-1}, number of seeds umbel^{-1}, seed yield and B:C ratio was maximum with 250 ppm Cycocel. Minimum number of days to 50% flowering and maturity and maximum carbohydrate content and protein content were noticed with 75 ppm GA_3. Similarly, lowest moisture content in seeds was also observed with 75 ppm GA_3, while, the essential oil content in seeds was maximum with 50 ppm GA_3.

Keywords: coriander, growth, plant growth regulators, quality, yield

Introduction

Coriander (*Coriandrum sativum* L.) is an annual spice and condiment that is mostly used for its pleasant aromatic odour. It is an important seed spice grown in Andhra Pradesh during *rabi* season for grain purpose under rain fed vertisols. The crop has to survive under residual soil moisture throughout the cropping period and generally experiences terminal moisture stress which results in poor yields, which is the major constraint in production in Andhra Pradesh (Sarada *et al.* 2008). Plant growth regulators (PGRs) have great potential in in-creasing agricultural production and help in removing many of the barriers imposed by genetics and environment. PGRs play an important role in mitigating stress and increasing flower set. Exogenous application of PGRs has been reported to improve the growth and yield of various crops (Bharud *et al.* 1988). It is well known that all the PGRs regulate the physiological functions of plant. Information regarding the use of PGRs suitable for rain fed vertisols in Andhra Pradesh is very meagre. Keeping this in view, the present field experiment was conducted to study the effect of PGRs on growth, seed yield, quality and economics of coriander.

Material and methods

The field experiment was conducted during *rabi* 2013-14 at Research Farm, Horticultural College and Research Institute, Dr. Y.S.R. Horticultural University, Anantharajupet, Andhra Pradesh. The soil of experimental field was sandy clay loamy in texture, with pH 7.4, low in available N (150.70 kg ha^{-1}), medium in available P (29.28 kg ha^{-1}) and high in available K (316.15 kg ha^{-1}). The experiment consisted of seven treatments including control (water spray), two concentrations each of GA3 (50 and 75 ppm), NAA (10 and 25 ppm) and Cycocel (100 and 250 ppm) as pre-soaking, foliar spray at 30 and 60 DAS, respectively replicated thrice in a randomised block design. Seeds were sown in the plot of 2 m × 2m at spacing of 30 cm × 10 cm. The crop was fertilized with 12 t of FYM along with NPK @45: 40: 30 kg ha^{-1} as basal. Another 15 kg N ha^{-1} was top dressed at 60 days after sowing. Growth regulators were applied as pre-soaking, foliar spray at 30 and 60 DAS as per the treatments and untreated control plots were sprayed with water. Need based cultural and plant protection operations were taken up to harvest. Five plant samples from each replication were selected at random to record data on morphological aspects, yield and quality attributing characters. The carbohydrate content in the seeds was estimated by the Anthrone method, the protein content in the seeds was estimated by the Lowry's method (Lowry *et al.* 1951), the essential oil content in the seeds was estimated by the steam distillation method and moisture content of the seed was determined on wet weight basis. The experimental data was analysed statistically by the method of analysis of variance as out lined by Panse & Sukhatme (1995). The economics of treatment was calculated on the basis of prevailing market rates.

Results and discussion

Morphological characters such as plant height, number of primary branches $plant^{-1}$, number of secondary branches $plant^{-1}$, days taken for 50% flowering and maturity showed significant variation with different concentrations of growth regulators (Table 1). Among various treatments GA_3 at 75 ppm recorded the highest plant height at 30 DAS (35.43 cm), 60 DAS (69.22 cm) and at harvest (78.09 cm). The increase in plant height is due to effect on increased cell elongation and rapid cell division in the growing portion leading to increased length of internodes. These results are in conformity with the findings of Kumar & Sundareswaran (2011) and Singh *et al.* (2012) in coriander. Number of primary and secondary branches $plant^{-1}$ was maximum with the application of Cycocel 250 ppm at 30 DAS (3.93 and 4.13, respectively), 60 DAS (7.00 and 13.40, respectively) and at harvest (7.13 and 16.13, respectively). The increase in number of primary and secondary branches could be due to suppression of apical dominance by the application of growth retardant Cycocel which diverts the polar transport of auxin towards the basal buds there by leading to increased branching. The results are in conformation with Kumar & Sundareswaran (2011) and Singh *et al.* (2012) in coriander. Days to 50% flowering and maturity decreased gradually with an increasing level of GA_3 from 50 ppm to 75 ppm which indicated GA_3 involvement in transition of vegetative apices to floral apices. According to Lang (1965) GA_3 could substitute for the proper environmental conditions which initiate early flowering (40.33 days) and maturity (85.00 days). Similar findings were reported by Singh *et al.* (2012) in coriander.

The yield, yield attributing characters and economics such as number of umbels $plant^{-1}$, number of umbellets $umbel^{-1}$, number of seeds $umbel^{-1}$, seed yield $plant^{-1}$ seed yield ha^{-1} net returns (Rs ha^{-1}) and B:C ratio also showed significant variation among the different concentrations of GA_3, NAA and Cycocel (Table 2). Application of Cycocel at 250 ppm was found to be the best for various yield attributing characters such as number of umbels $plant^{-1}$ (28.00), number of umbellets $umbel^{-1}$ (6.33), number of seeds $umbel^{-1}$ (34.73). Obviously the projected seed yield $plant^{-1}$ and seed yield ha^{-1} was maximum with Cycocel 250 ppm (9.02 g and 18.46 q ha^{-1}, respectively). The increase in seed yield ha^{-1} might be due to increase in yield

Table 1. Effect of pre soaking and foliar sprays of plant growth regulators on morphological characters of coriander

Treatments	Plant height(cm)			Number of primary branches plant^{-1}			Number of secondary branches plant^{-1}			Days to 50% flowering
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	
GA_3 50 ppm	32.47	67.12	75.11	3.33	6.33	6.47	3.47	12.33	15.33	41.67
GA_3 75 ppm	35.43	69.22	78.09	3.67	6.67	6.87	3.87	12.73	15.47	40.33
NAA 10 ppm	28.77	63.25	71.37	2.87	5.73	5.93	2.93	11.27	13.67	44.00
NAA 25 ppm	30.97	65.05	73.09	3.13	6.00	6.07	3.20	11.87	14.80	43.00
Cycocel 100 ppm	25.35	57.79	66.23	3.53	6.60	6.87	3.73	12.67	15.47	46.67
Cycocel 250 ppm	24.57	54.71	62.34	3.93	7.00	7.13	4.13	13.40	16.13	45.33
Control	26.31	60.46	68.02	2.47	5.40	5.60	2.67	10.40	12.93	47.33
CD (P<0.05)	0.56	1.02	0.65	0.20	0.30	0.25	0.20	0.65	0.63	1.82
CV (%)	1.09	0.92	0.52	3.52	2.69	2.24	3.25	3.04	2.04	2.33

Table 2. Effect of pre soaking and foliar application of plant growth regulators on yield and yield attributes and economics of coriander

Treatments	Umbels plant^{-1}	Umbellets umbel^{-1}	Seeds umbel^{-1}	Seed yield (g plant^{-1})	Seed yield (q ha^{-1})	Days to maturity	Net returns (Rs. ha^{-1})	B:C ratio
GA_3 50 ppm	24.00	5.87	30.93	7.21	15.58	86.33	1,14,465	3.49
GA_3 75 ppm	25.93	6.07	33.00	8.02	16.99	85.00	1,27,407	3.84
NAA 10 ppm	22.07	5.53	25.53	6.30	13.49	88.67	95,449	2.97
NAA 25 ppm	23.00	5.73	27.20	6.80	14.68	87.67	1,06,649	3.32
Cycocel 100 ppm	26.60	6.00	32.53	7.83	16.64	91.00	1,23,248	3.62
Cycocel 250 ppm	28.00	6.33	34.73	9.02	18.46	90.00	1,38,947	3.91
Control	16.93	5.27	23.47	5.33	11.29	92.33	74,690	2.33
CD (P<0.05)	1.38	0.20	1.68	0.92	1.44	2.14		
CV (%)	3.29	1.98	3.21	7.22	3.21	1.36		

Table 3. Effect of pre soaking and foliar application of plant growth regulators on quality characters of coriander

Treatments	Moisture (%)	Total carbohydrates (%)	Total soluble proteins (%)	Essential oil content (%)
GA_3 50 ppm	10.34	20.07	15.01	0.43
GA_3 75 ppm	9.19	23.09	16.12	0.42
NAA 10 ppm	13.01	18.51	14.11	0.38
NAA 25 ppm	11.86	19.27	14.90	0.39
Cycocel 100 ppm	12.28	17.20	13.51	0.35
Cycocel 250 ppm	11.04	18.05	13.78	0.36
Control	13.48	14.02	11.57	0.32
CD (P<0.05)	1.10	1.12	0.39	0.02
CV (%)	5.33	3.39	1.54	3.24

attributes such as number of umbels plant^{-1}, number of umbellets umbel^{-1}, number of seeds umbel^{-1}, seed yield plant^{-1} and increase in growth parameters like number of branches (primary and secondary) plant^{-1}. Regarding economics, maximum net returns and B : C was obtained with Cycocel at 250 ppm treatment, *i.e.* Rs. 1,38,947 ha^{-1} and 3.91:1, respectively. This might be due to higher seed yield of coriander with 250 ppm Cycocel as against other treatments. The results are in conformity with the findings of Sarada *et al*. (2008), Kumar & Sundareswaran (2011) and Singh *et al.* (2012) in coriander.

Quality characters, such as moisture content, total carbohydrate, total soluble protein content and essential oil content in seeds were also significantly influenced by various treatments of GA_3, NAA and Cycocel (Table 3). Both carbohydrate and protein content were maximum with GA_3 75 ppm (23.09% and 16.12%, respectively). It might be due to the increase in leaf chlorophyll content leading to increased photosynthesis and photosynthetic CO_2 fixation providing more carbohydrates and proteins for metabolism and for export to sink. Low moisture content (9.19%) in seeds treated with GA_3 75 ppm treatment, might be due to the efficient translocation of photo assimilates from leaf and stem to seeds resulting in increase in seed dry weight. The essential oil content in seeds was highest in GA_3 50 ppm (0.43%) and showed a declining trend with increase in GA_3 concentration. The above results are in conformity with the findings of Meena (2005), Panda *et al.* (2007) and Singh *et al.* (2012) in coriander.

From the results it can be concluded that higher concentrations of both Cycocel 250 ppm and GA_3 75 ppm significantly influenced growth parameters, seed yield and yield attributing characters. However, from the quality point of view, 50 ppm GA_3 was found to be superior and with regard to economics, higher B: C ratio was recorded with Cycocel 250 ppm.

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